ReFUEL Laboratory

NREL's ReFUEL Laboratory

NREL's new Renewable Fuels and Lubricants (ReFUEL) Research Laboratory will be used to facilitate increased renewable diesel use in heavy-duty vehicles. Because renewable diesels like biodiesel and E-diesel can be used to displace imported petroleum, they can have a positive impact on our national energy security. In addition, research at ReFUEL will be used to help engine manufacturers meet the increasingly stringent heavy-duty emission standards that will be required beginning in 2007.

ReFUEL's Heavy-Duty Chassis Dynomometer

What is the ReFUEL Lab?

The **Re**newable **Fue**ls and **L**ubricants (ReFUEL) Research Laboratory is NREL's unique high-altitude facility for testing alternative and advanced fuels and heavy-duty engines and vehicles. The lab is equipped with specialized testing and measurement equipment, including a chassis dynamometer, an engine test cell, and a fully equipped emission test bench. ReFUEL is the first lab in the United States dedicated to researching and developing renewable and synthetic fuels and lubricants for heavy-duty transportation applications.

ReFUEL's mission is to provide the facilities required to identify, test, and evaluate renewable and synthetic fuels and lubricants for use in ground transportation, to enable high efficiency operation while displacing petroleum products. The laboratory will also be used to evaluate and develop heavy hybrid electric vehicles and to conduct cross-cutting research for NREL's Center for Transportation Technologies' Fuels Utilization Program.

How do the pieces fit together?

The heavy-duty chassis dynamometer for developing advanced trucks and buses

Fuels, engines, and emission controls work together as a system, and may behave differently when installed and tested in trucks and buses. For example "in-use" performance may differ from engine lab performance or the fuel or system may work differently due to regional considerations such as altitude or ambient temperature. In addition, manufacturers need to ensure that their systems are robust and some agencies may require verification of emissions control systems before they can be introduced into the marketplace.

ReFUEL is one of only six heavy-duty chassis dynamometer emissions laboratories in the nation. The lab's heavy-duty chassis dynamometer features tandem 40-inch diameter rollers that can accommodate dual axle trucks up to 52,000 pounds, can absorb 380 axle-hp at 30 mph, and can motor vehicles up to 360 axle-hp at 30 mph. This equipment accommodates a dual-axle truck that is operated over a drive cycle which is displayed on a computer monitor mounted in front of the vehicle operator. Vehicle exhaust is diluted with air and flows up vertical tunnels to the emissions measurement room on the second floor.

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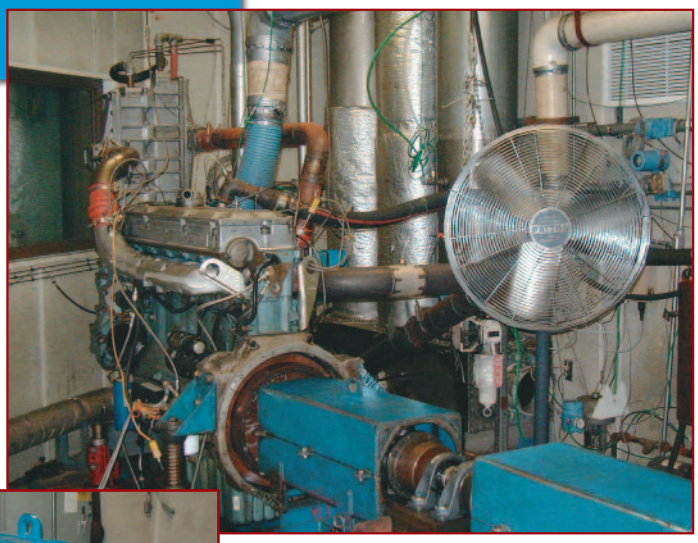
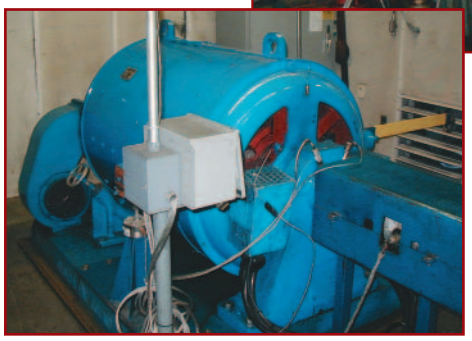


ReFUEL's Heavy-Duty Engine Test Cell

Heavy-duty engine test cell for fuels research and development

The research and development conducted at the ReFUEL Lab will focus on renewable fuels that can be blended with petroleum fuels and are compatible with existing and future engine designs. This research is important because by 2007-2010, U.S. engine manufacturers will be required to meet increasingly stringent emissions requirements. Unfortunately, emissions reductions often come at the expense of fuel efficiency. Therefore one of the primary goals of the ReFUEL Laboratory is to investigate new fuels that will enable emissions to be reduced without compromising the superior energy efficiency of today's diesel engines.



The engine test cell consists of rooftop units that control the temperature and humidity of the intake air and a heavy-duty engine coupled to a DC (direct current) electric dynamometer. The engine test cell dynamometer is rated at 450 hp at 5000 rpm and has a 1500 ft-lb peak torque. Engine speed and torque are controlled for both steady state and transient test schedules. The exhaust is diluted with air and flows up vertical dilution tunnels to the second floor emissions lab.

Emissions analysis laboratory

NREL investigates fuels and lubricants that can reduce both regulated and unregulated emissions species. Analysis allows researchers to better understand the composition of exhaust emissions and to estimate the impacts on the environment and human health.

ReFUEL's emissions laboratory is used to measure emission, monitor system performance, and measure the fuel consumption of the chassis dynamometer and the engine test cell. The laboratory uses a Pierburg emission bench to measure gaseous emissions including regulated emissions like carbon monoxide, total hydrocarbons, and nitrogen oxides. Carbon dioxide, nitric oxide, and nitrogen monoxide are also measured.

Particulate matter is collected on 70 mm Teflon filters using a Pierburg PM sampling bench. Particulate matter filters are subsequently weighed using a microbalance. Hydrocarbon emissions are speciated by collecting bag samples for processing at other labs. In addition, NREL labs in Golden, Colorado, can further characterize unregulated exhaust emission species. The ReFUEL Lab conforms to EPA Code of Federal Regulations 40 Part 86, Subpart N.

What happens next?

Future developments at the ReFUEL lab will include adding a fuel chemistry lab that utilizes existing NREL/Golden lab capabilities and which is enhanced with new instrumentation. NREL also intends to increase its in-house capabilities for molecular characterization, fuel property measurement and analysis, and sample preparation. Researchers in the lab will continue to study complex fuel-engine interactions and to establish correlations between fuel molecular structure, combustion/reaction quality, and thermal efficiency and emissions.

Over the last 30 years, medium- and heavy-duty trucks have been one of the fastest growing fuel use areas in the transportation sector. The ReFUEL Laboratory provides the facilities required to identify, test, and evaluate renewable and synthetic fuels and lubricants for use in heavy-duty ground transportation. This will enable high efficiency operation while displacing petroleum products and reducing emissions.